Who's Afraid of CDT?*

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Current Conceptions of CDT
The new band wagon in primary education is Craft Design and Technology. Before it gets too much momentum, we should hold it still to examine more closely what it is that we are being encouraged to jump on. Current conceptions about CDT in primary schools appear to have derived from secondary curriculum practice, for it often seems to be presented in ways that make it easy to think of it as a separate 'subject', or as part of Science.

For example, despite their broad conception of CDT as a problem-solving activity applicable across the curriculum, in *The Curriculum From 5 to 16* HMI present it in the following terms (para 74):

> 'Subjects (sic) such as home economics and CDT enable pupils to apply and investigate scientific principles . . .

And (in para 83/84) in discussing what HMI call the technological area of experience, there is almost what amounts to a call for CDT to have a separate curricular existence, equal to other more conventional curriculum subjects.

> 'Learning about technology and its historical and social consequences and exploring the opportunities to apply scientific principles that involvement with it makes possible, have long featured in the work of schools. Such work should continue and, if anything, be increased in scale and range. But work of that kind does not of itself make up a technological area of learning and experience sufficiently delineated and comprehensive to stand alongside the other, more firmly established, areas that should feature in a broad curriculum. The study of the impact of technology and its social and environmental 'spin-offs', however interesting, is no substitute for active involvement in the process itself.
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> All pupils throughout the 5-16 period should be so involved. The essence of technology lies in the process of bringing about change or exercising control over the environment. This process is a particular form of problem solving: of designing in order to effect control. It is common to all technologies including those concerned with the provision of shelter, food, clothing, methods of maintaining health or communicating with others, and also with the so-called high technologies of electronics, biotechnology and fuel extraction and the alternative technologies of the Third World. As in all learning, the involvement must be characterised by progression, internal coherence and continuity. But technology also has its content which, while not exclusive to it, is essential to the technological process. That content broadly concerns the nature and characteristics of natural and manufactured materials, and the nature, control and transformation of energy'.

Strictly speaking, of course, 'areas of experience' are not 'subjects', but the problem with presenting the case for CDT as a distinctive area of the curriculum, linked to science, is that the response of many primary school teachers is likely to be negative. They may well react to HMI proposals much as they did to Science in the 1970s — with a sense of both fear and professional incompetence, except that this time there is the further problem that teachers will see it as one more subject which they have to incorporate unresourced, into an already overcrowded timetable, or as just one additional burden to all the new priorities (SEN, multi-culturalism, diagnostic assessment, micro-computer applications, able children etc) currently hovering over them.

CDT as an Approach to Learning
This reaction, though understandable, would be a pity. For years many primary school teachers have been involved in CDT to some extent, perhaps without realising it. We have worked with our children in groups as they have identified problems, posed solutions and tested them through designing, making and evaluating models which illustrate their investigations, in history, geography, mathematics, art craft and language. The value of these models has been immense not only for the children who have made them but also for those who have seen them on display. It is this experience that could be built on to extend CDT in primary schools. This view of CDT, an approach to learning across the curriculum characterised by co-operative group work, exploratory language focussed on defining problems, model making to test possible solutions, and appraisal of results, is not new. It was advocated as a learning approach by Plowden in 1967. And that is its advantage. It starts from where many teachers already are. Primary school teachers could come to realise that they have been 'doing CDT' to some extent already, and can extend it simply by reflecting upon the possibilities for practical problem solving in more curriculum areas.

The practical aspect of actually asking children to work in groups to discuss ideas, identify problems, decide upon an approach, to draw preliminary plans, to collect all their materials, to construct a model from their initial plans and to evaluate how their final model has differed from their original idea, is the vital progression of a whole range of theoretical, practical and co-operative skills. It is important for the children to draw plans of the finished item and then to write notes illustrating and highlighting any difficulties that arose and explaining how their ideas might have changed as practical problems were overcome. This is the precise procedure in miniature followed by those in industry who innovate and improve.

In this way, a model of say a Norman Castle could pose problems of structure and stability, measurement and calculation, design and construction. It could lead on to work on patterns of bricklaying which can make strong walls and arches, and a whole range of investigations into building techniques ancient and modern. In addition, the construction of a seige machine will introduce children to projectiles and at this point you would probably have to decide whether or not to forget the Normans and follow the natural curiosity of the children and widen your work to study flight.

Admittedly CDT in its present widely accepted sense is much less of a problem for the teacher who has some experience in science, as by its very nature it is practical and relies to an extent upon scientific principles, but this emphasis is restricting. Micro-computers were initially regarded as a tool for the mathematician until it was accepted that they had a wider use across the curriculum. So too, with CDT. It is not something which stands on its own but rather extends into most subjects and is the tool whereby investigations or demonstrations of ideas are made possible. It is probably one of the highest order problem solving activities in which children can engage. The interest is self-generating and the match between the individual's ability and the work she or he is doing is high.

The Development of CDT in my Class

The work in my own school went through two stages; that in my own classroom and that done by other teachers in response to my suggestion that we organise a CDT exhibition in the school.

As the teacher responsible for CDT in the school, I had successfully negotiated with the local authority inspectors some help in providing a basic tool kit, some of it redeployed from secondary schools. And my head had let me spend a further £400 on material from catalogues. Parents responded keenly to requests for raw materials, as did one or two local firms, and the local hospital. From these community sources, I finished up with amongst other things, a ready supply of:

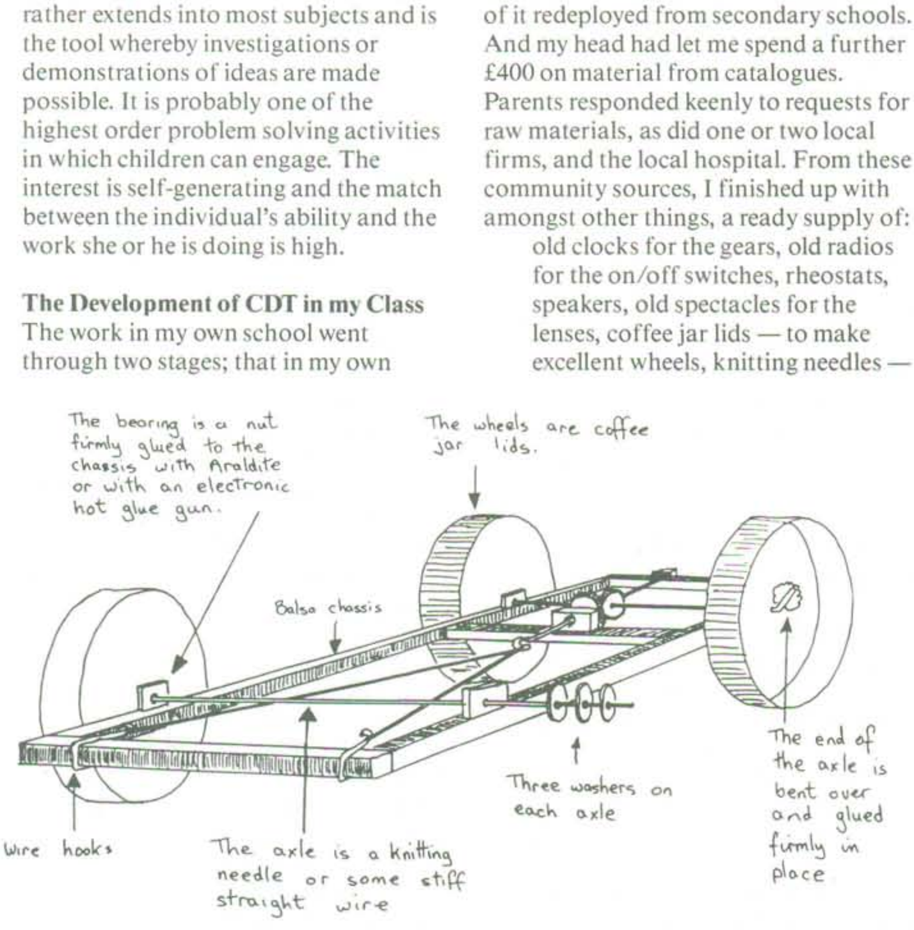
old clocks for the gears, old radios for the on/off switches, rheostats, speakers, old spectacles for the lenses, coffee jar lids — to make excellent wheels, knitting needles — to make excellent axles, injection syringes — to make hydraulic systems, and so on.

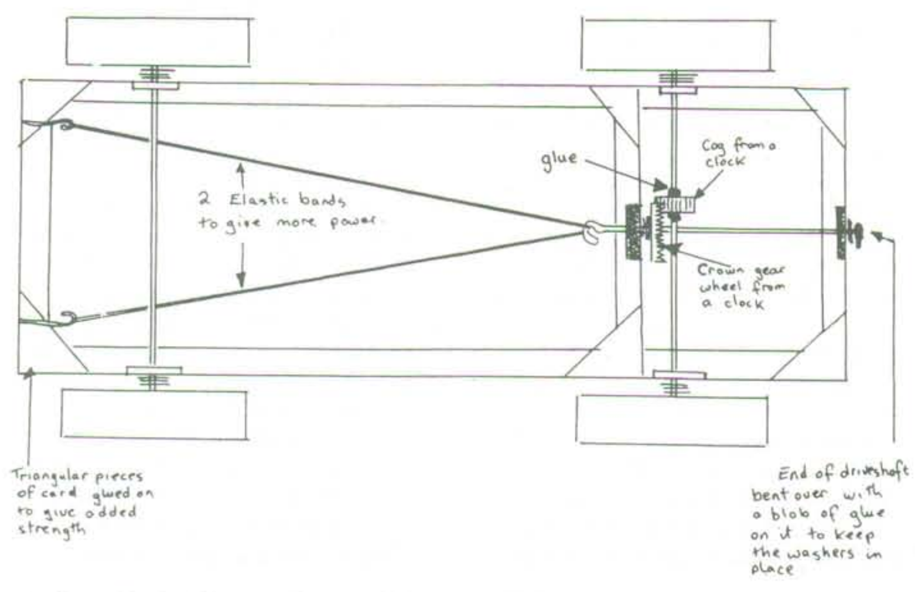
By this means, I had created a resource base for the work.

In my own class of top juniors, my basic aims are to give children a sense of control over technology/science/the social world, by giving them the responsibility for identifying their own problems, and arriving at solutions. For this reason, I did not, and do not, have a written syllabus or scheme. If this happens, it means that there is a 'correct' answer somewhere in the back of the teacher's mind. Also I want to allow my children the privilege of embarking upon an idea that we can see may lead nowhere. But because the children are able to argue well that they should pursue that particular avenue, they themselves must reach the decision that their original assumption was wrong. It has to be monitored carefully, of course, and skilled guidance must be given so that valuable time and enthusiasm are not wasted; when children realise that they are up in blind alley, I have to be ready to step in, resume and redirect their energy, interest and enthusiasm. The ability to tolerate ambiguity is a pre-requisite for high level problem solving, and therefore I as a teacher have to be working and learning with the children as an integral member of the design team, rather than an overseer or director.

My basic classroom organisation is very flexible. Apart from time set aside for Maths and English, the rest of the time is divided up between PE, TV, and what I call Research. Over the year this covers a wide curricular range, and always includes language, mathematics, history, geography, art and craft. This time is used to develop topics that have arisen from some other aspect of the children's work, and at any one time you might find a group writing poetry, drawing detailed plans, reading for pleasure, writing up an experiment, painting, or many other things.

A key characteristic of most group activities is a problem solving approach, related to the work they are doing. I always allow a group to select itself around a point of interest. They discuss and identify a problem, and postulate theories as to its possible solution. They become a design team.





One such group was working on a project on Transport which, as a spin-off considered cars as transport and as performance vehicles. I involved myself early on:

> 'O.K. These cars use petrol, but I wonder if it is possible for you to build a vehicle which will travel more than 1 metre under its own power. You can't shove it or roll it down a slope. You must let it go from a standing start'.

Much pencil sucking goes on for about half an hour. Soon diagrams appear on scraps of paper. An argument about a power unit occurs. Other children are drawn in. There are two schools of thought. One favours elastic bands and the other favours electric motors. More pencil sucking, more plans, more arguments. Another split is occurring. Someone wants to use jet power, and they think a balloon will do. Eventually there are five distinct design teams discussing, exchanging ideas in a sort of mutual guarded secrecy because they want to have the winning design.

The designs are shown to me and with one or two suggestions they have my blessing to proceed. After weeks of trial, re-design, improvement, wonderful use of language both spoken and written, mathematical calculations and measurement, interaction within a group, modifications, trials of theories based on scientific ideas and knowledge, we had a variety of vehicles.

There was a basic four wheel drive car powered by an elastic band. But the children wanted to improve its performance. They found out that to 'triangulate' the elastic band gave more power, but to do this they had to build a stable rectangular frame, (see digram).

This diagram shows the solution that one group of 'average' children arrived at after a great deal of trial and error, dogged perseverance, and downright hard work. They had had to overcome friction in the axles, and turn the energy provided by the elastic bands through 90° to power the back wheels. They had to solve problems of stability and rigidity as well as a whole range of other difficulties that they encountered.

An interesting discussion arose in this group regarding the numbers of teeth on different cogs, which developed into a peripheral study on gear ratios. The children created experiments for themselves with cogs where they investigated how many teeth were on this or that cog, and how many times it went round when driven by the first cog. There was even a rather optimistic discussion on whether or not to try to develop a gearbox to make the car go even faster, but at this point the children realised their own limitations. What had happened, however, was that their eyes had been opened to a new dimension of experience, and although they had no immediate practical solution to their problem, they had been engaged in postulating theories, and in exploring the problem through intellectual reasoning.

When they returned to the task in hand, a more basic but nevertheless important intuitive modification was made, where they decided to put sandpaper on the rear wheels to increase friction with the floor because when they gave the elastic 20 turns the back wheels spun and that was a waste of energy.

Because the car travelled in a curve, some other children tried a rudimentary form of steering based on a 3 wheeled vehicle which they thought would go further because it was lighter. It did, and it went in a straight line.

The balloon powered cars managed to travel one metre, but only when someone discovered that if you put a button in the neck of the balloon, you restrict the emission of air and increase the duration of the thrust. They also discovered inertia because the vehicle kept moving after the balloon had gone down.

The electric motor powered cars ran by (a) rubbing the motor spindle on the back wheel, (b) using an elastic band in the same way as a bicycle chain, (c) using gears taken from clocks.

One group wanted forward and reverse and stop without having to fiddle around with changing wires. They wired up to a household two way lighting switch themselves! The electric cars, the children decided, would go as long as the batteries would allow them to, so how were they to choose the best car? One of the children, considered least able in conventional terms, suggested building a ramp out of a plank on bricks and gradually increasing the slope.

This posed new challenges for them. They too put sandpaper on the wheels, experimented with centre of gravity to stop the cars flipping over and so on. Eventually, a girl and a boy came up with the best design: a four wheel drive electric powered car with forward, reverse and stop, together with a variable speed control (this was a volume control from an old tape recorder) which would climb a slope of 41°. I wonder if Range Rover can match that!

Developing CDT Through the School

It was relatively easy for me to develop the approach in my own class. But what about other classes in the school? I had to motivate them. They had been aware that something peculiar had been going on in my room, because occasionally things whirred down the corridor or flew through the air, or buzzed or chimed. Strange machines were being made and tested.

I went to the teachers, in turn, and discussed with them what work they would be doing next term, and carefully raised with them some possibilities for building in a more explicit problem solving approach. In our staff meeting I threw out what I now realise was a bombshell.

> 'How about us all getting as much CDT work as possible out of our topics, and let's share a CDT exhibition in the school?'

Stony silence!

But I urged them to do it, pointing out examples across the curriculum:

Art: colours, the eye, lenses, chromotography, dyes, etc.

History: Great inventors and designers such as Archimedes, Newton, Da Vinci, Flight, Boat, Cars and improvements in the designs.

Drama: Create a stage in a cardboard box, use puppets and light it with torchbulbs and switches.

In short, I asked the staff to think of their own strengths, to come to me with their topics, and see how we could plan to integrate the CDT approach into them. I argued that they should see CDT as an 'enabler', an approach that would enable them and their children to extend their existing work by improving the quality of its problem solving potential. And they agreed, some with more silent reservations than I knew at the time. But once committed to an open week exhibition, they responded positively, and some examples of their work illustrate how well 'non-specialists' can add new dimensions to their work through CDT.

A class of first year juniors had begun some work on food and were investigating crops and diet and so on, when one girl decided that she wanted to make a model of a windmill. The teacher expected the model to be the usual box with some sails stuck on the front, but the little girl wanted more than that. She decided that she wanted to wind a handle at the back and make the sails go round. The teacher gave her all the support and confidence she needed but when the model was complete, she still wasn't satisfied.

In her mind she had a picture of her model looking and functioning like a real windmill. She cut the side out of the windmill and made cogs out of cotton reels with lolly sticks stuck into them. She put in a vertical driveshaft which had two more cotton reels at the bottom representing the millstones. There were three floors inside her windmill complete with storage bins, sacks, with real corn, and sacks with real flour in them. There was a miller and his cat and a whole range of tools and milling equipment.

When the handle was turned, the sails went round, the top millstone turned and some flour which had been carefully put into the top cotton reel trickled out from between the millstones.

The model was a joy to see especially when you realised the range of skills that the little girl had experienced. She had researched her ideas from books and a visit to a water powered mill, and modified her model according to the materials which were available to her. She was evaluating her ideas and theories and was developing them into real problem solving areas. She was communicating her ideas and enthusiasm to others not only in what she was making, writing and drawing, but in what she was saying.

As a direct result of her enthusiasm and her teacher's skill and ability to recognise a new and exciting area of work, other children became interested in cogs and pulleys, and a whole range of experiments sprang up which investigated energy transfer. Children worked in self-selected groups and they nailed cotton reels into pieces of wood and looped elastic bands around them. When one cotton reel was turned, they all turned. Some went forwards and some went backwards and the children found out why for themselves. Other children used crown caps from beer bottles in the same way except that the wavy edges of the caps interlocked like cogs. Not only did this work provide the children with an enormous practical experience, but these models made superb kinetic pictures on the wall. The scientific and aesthetic came together for a class of 7-8 year olds. (I don't think they were ever separate in the first place although I am sure there are many who will dispute that point).

Fortunately the class teacher concerned was flexible enough in his ideas to realise the potential of this work and to have the courage to change direction rather than to doggedly stick to his original scheme of work. The children gained much experience in mechanics, language, art, mathematics, geography, history, manipulative and practical skills and so on. Eventually the work became a study of energy in its various forms and it enhanced the original idea of food, which is after all one of our own prime sources of energy.

Another class which was involved with some work on art diversified into the study of colour. They investigated how paints mixed and compared the results with the way light mixes. They split white light into the spectrum of colours and then tried to re-mix those colours using spinning tops with the 7 segments coloured in. The work developed into chromatography and then to a study of the eye which led on to work on lenses. Using the information they were gaining the children developed their work in groups into making simple telescopes, cameras and optical toys.

There were numerous other examples. Perhaps one of the most interesting pieces of work was done by a second year class who were considering space. Not outer space, but inner space. The space between objects, people and events. Space within structures, creatures, music, poetry, maths and art and so on. And there was the music topic in which the children's creativity led them to invent and play their own musical instruments and to discover the connection between frequency and pitch. A first year class working on a maths project concerned with time came up with fascinating ways of measuring time and subsequently wrote and performed a marvellous assembly about it.

Conclusion

The CDT exhibition in the school was a great success; the school opened itself up to its public for a week, with each class supplying, on a rota, a team of 'boffins' to demonstrate its displays, and to talk about the work. Everyone in each class, irrespective of ability, had a turn at being boffin, and did the job with enthusiasm and pride. Our visitors included parents and other members of the community, the local press, advisers and inspectors, and education officers. They found enthusiastic children, anxious to share their learning with them, by showing them how things worked, and how some other things worked even better!

Behind these public scenes, something else had happened. The staff as a whole had grasped the nettle and created an extended dimension to their curriculum practice. For me this was best illustrated by one of my colleagues, a first year teacher who had found the approacn rather challenging but at the same time exhilarating. Emerging from her classroom one day as the exhibition's opening day approached, her arms full of pictures, models, plans, writing etc, to be displayed in the corridor, she saw me. 'Oh, I have had a good day, and just look at all the work they've done for me!'

What I look for in the future, is not a wrangle between polarised factions in education, arguing about whose definition of CDT will be the dominant one. Instead, I hope that primary school classteachers, perhaps with a little help from their technically-minded friends, will come to see the potential for their normal work that resides in the movement for CDT. For it could be the best thing to come their way in a long time. Through the kind of approach I have been illustrating, we can go some way to reclaiming what used to be called 'progressivism'. We can demonstrate that children's learning does not proceed through adult notions of 'subjects', and can implement a problem-solving approach to learning across the curriculum that stresses children's definitions and children's solutions.